MONITORING TECHNIQUE IMPROVES REBURN EFFICIENCIES BY BALANCING NO_X/CO

Background

Since the 1970's the Utility Industry has been faced with greater pressures from the EPA to reduce the flue gas emissions of SO_2 and NO_x. NO_x emissions have been reduced on a steady basis by improving the different elements of the combustion process, by installing low NOx burners, incorporating gas reburn technology and lately by installing SCR or SNCR units.

A large number of countries have been introducing a very expensive method of reducing NO_x, using SCR and SNCR. These processes require a large capital outlay for the installation plus high operating expenses, since they require the injection of ammonia and/or urea, to reduce NO_x emissions. The U.S. industry has consistently tried to find ways by which NO_x reduction can be achieved, relatively inexpensively, and with the new Ozone Season limits beginning this year, it is becoming more of a requirement.

Land Combustion has been participating in a series of tests in conjunction with a research company at a Mid-Atlantic utility where an innovative yet inexpensive technique has been tested in order to further reduce $NO_{x,}$ thus minimizing the need for a very expensive SCR unit. This technique which utilizes the concept of the gas re-burn technology itself, by the injection of natural gas at the radiation area, has the added advantage of requiring less capital outlay. The natural gas is injected in grid form, reacting with the flue gas at a high temperature, creating a reducing atmosphere which can decrease NO_x levels, while providing the potential to increase CO levels.

This technology requires a way to identify in what section of the boiler the injection is more effective. The risks are high because we could create high levels of CO in some specific sections. In other words we could over inject in one section, while we are under injecting at the other end, therefore, not achieving the final objective of lower NO_x with minimum CO.

In this facility the new Fuel Lean Gas Reburn (FLGR) technology is combined with two other NO_x reducing processes, SNCR and Low NO_x burners. This complex low NO_x system creates a situation whereby multiple control systems require fast and accurate data on the flue gas content in order to overcome the risk of imbalance.

By monitoring NO_x, CO and O_2 close to the reaction zone, with a fast, accurate and simple system, we can provide the control information required to balance this natural gas injection system in the different levels of the boiler. Instantaneous readings of all three parameters ensure the balance between CO and NO_x is maintained under all load conditions, and varying conditioning rates, thereby optimizing the most cost effective method for maximum NO_x reduction.

FLUE GAS MONITORING

New techniques in monitoring and sampling have made it possible to provide fast response, accurate measurement and low cost systems to measure the three prime parameters required (O_2, CO and NO_x) even in the high temperature zones before the economizer of a Utility Boiler. This method allows for either continuous averaged, multipoint sampling (for large ducts) for trending purposes, or single point continuous for greater control in combined NO_x reducing systems.

Monitoring

The use of electrochemical sensor technology allows for a small, low cost flue gas analyzer capable of being mounted in the area of the sampling ports. These sophisticated continuous "close-coupled" extractive systems provide a very affordable solution, with its self contained control system and full automatic calibration capability using "live" gas provides for a high degree of accuracy normally associated with Continuous Emissions Monitoring Systems. Diagram 1 outlines the simplicity of the system, showing the actual layout of the analyzer. Note that this enclosure is only 2 ft. x 2 ft.

Sampling

In order to determine the best location for sampling, it is normal that during the initial phases of setting up the F.L.G.R. System, a load profile similar to Diagram 2 will be derived using standard EPA methods and analysis techniques. This diagram shows a 12 point matrix indicating the stratification at that plane. Four ports were used, each having short, medium and long probes.

Based on this information, these profiles will ultimately provide the best sampling points, as well as the number of points required.

Having determined the number of points required, based on the level of control needed, a sampling system with either single point continuous monitoring or an averaging capability can be designed. This system must have the ability to maintain the integrity of the sampled gas along with preventing plugging and corrosion of the whole system. For example;

In the case of the profile shown in Diagram 2 it was determined that the two central points using medium (6ft.) length probes in ports B and C were representative of the zonal injections for maximum NO_x reduction using the F.L.G.R. system.

However, for overall trim capability when combining S.N.C.R. and F.L.G.R. the boiler operations staff determined that a multipoint averaging system, as shown in Diagram 3, would provide more information.

Diagram 3 shows a 4 point averaging system with integral sample measuring chamber. The system response calculation takes into account equalized lengths of 1/4" high temperature line and the averaging chamber resonance time. Typical system response including the analyzer, to a 90% step change is less than 60 seconds, providing a fast enough response to any process change.

OVERVIEW OF MONITORING SYSTEM PERFORMANCE

In order to prove that this innovative method of monitoring can provide the accuracy and speed of response required by the NO_x control system, Land Combustion utilized a standard FGA 950E NO_x, CO, O_2 flue gas monitoring system with high temperature probe showing the practicality of using a miniaturized monitoring system in such a hostile environment as the operating platform at the economizer outlet of a 300 MW coal fired utility boiler (Diagram 4).

The analyzer was mounted on the main support structure with its back to the economizer ductwork, and the sample line run was approximately 10 feet. The 2 meter probe was placed in the center port of a 5 port matrix. Standard EPA method sampling was carried out to either side at the same insertion depth to provide an accurate comparison and relative accuracy check. Previous mapping, as in Diagram 2, had shown that for this specific process, which was a combined Urea injection S.N.C.R. and F.L.G.R. System, that the centroidal ports gave the best indication of NO_x reduction.

As the conditions varied in the process, the Land Combustion system tracked the standard method monitors very closely, providing a direct indication to the suitability of the system to the application, as can be seen from the trends of CO, NO_x and O_2. The time delay differential between the EPA methodology versus the FGA system were in the order of 60 seconds, however, the test van was located only 60-70 feet away from the sample ports.

From the testing carried out over a 30 day period, determination of suitability and location was achieved. Using the fast feedback from the localized monitoring system, the operations staff were better able to adjust any injection rates, or vary the gas reburn to obtain the most favorable NO_x results while maintaining the CO levels below 100 ppm.

SUMMARY

Although a good C.E.M.S. provides accurate data that could be used for trending, the use of a highly accurate measuring system located closer to the NO_x reduction system would help identify poor performance in individual zones. Therefore, improving operations ability to maximize injection rates, for maximum efficiency in both emissions reduction and combustion optimization. The FGA 950E provides this capability, in a very cost effective way.

By having an accurate monitoring system which gives us the level of CO, O_2, and NO_x at different points as close to the combustion zone as possible, we should be in the optimum position to minimize NO_x and CO emissions, thereby maximizing efficiency. This can now be achieved by using this low cost, low maintenance, fast response technique.

Finally, if further NO_x reduction is required (due to increased legislation) by the addition of S.C.R. technology, then the location of such a monitoring system would provide the feed forward signals for inlet conditions to the S.C.R. Thus providing first stage feed back for S.C.R. optimization. Then with the addition of a second system after the S.C.R. the source can provide the required data to show total NO_x reduction.